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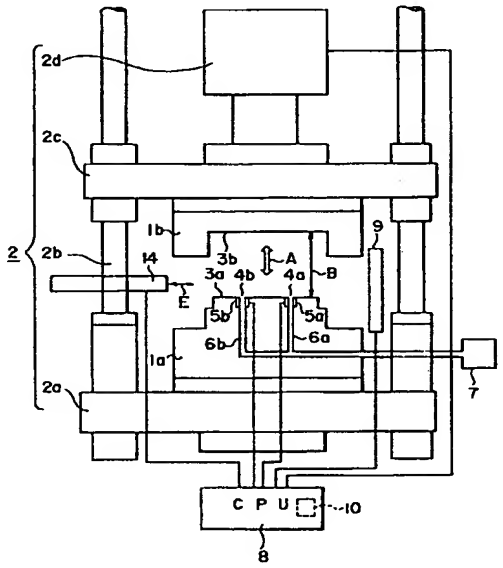
(54) Method for producing thermoplastic resin molded article and mold assembly therefor

(57) A method for producing a thermoplastic resin molded article comprises steps of (a) supplying a first molten thermoplastic resin from a first resin-supplying gate to a first portion of a cavity formed between a cavity face of a first mold and a cavity face of a second mold, said first and second molds being in an open state; (b) closing said first mold and said second mold to set the cavity in a closed state; (c) injecting a second molten thermoplastic resin from a second resin-supplying gate to a second portion of the cavity in the closed state; (d) cooling and solidifying said first and second resins in the cavity in the closed state; and (e) opening said first mold and said second mold to remove said molded article. A resin molded article having a uniform surface and an excellent outer appearance can be efficiently and easily produced under a relatively low pressure while preventing luster variations or wrinkles at a portion of the surface of a desired molded article, which portion requires an excellent outer appearance or has a designed surface.

Fig. 1



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Description

The present invention relates to a method for producing a thermoplastic resin molded article and a thermoplastic resin molded article (multilayer molded article) partially laminated with a skin material.

Thermoplastic resin molded articles and thermoplastic resin molded articles having skin materials laminated thereon are widely used for interior automotive parts (e.g., a door trim, a rear trim, and an instrument panel), interior and exterior parts of home electronic equipments, and the like.

A method for producing such a thermoplastic resin molded article and a resin molded article laminated with a skin material is described in U.S. Patent No. 5,154,872. Further, a method of producing a resin molded article laminated with a skin material is described in Japanese Patent Publication (Kokoku) No. 4-26289 (corresponding to Japanese Patent Laid-Open No. 63-11312).

The present inventors found that the above conventional methods had the following problems.

In the method described in U.S. Patent No. 5,154,872, luster variations or wrinkles called charge marks tend to be generated on the product surface near resin-supplying gates, resulting in a poor outer appearance of the product. Further, in producing a molded article partially laminated with a skin material by using the conventional method, if the desired molded article is relatively large and thus a molten resin-supplying gates in the molds is present in an area which is not laminated with the skin material, luster variations or wrinkles tend to be generated on the product surface of the area, resulting in nonuniformity and a poor outer appearance.

It is an object of the present invention to provide a method for efficiently producing a resin molded article having a uniform surface and an excellent outer appearance while preventing luster variations or wrinkles at a portion of the surface of a desired molded article, which portion requires an excellent outer appearance or has a designed surface, without making the apparatus bulky, even in producing a large thermoplastic resin molded article.

It is another object of the present invention to provide, even in producing a thermoplastic resin molded article (multilayer molded article) partially laminated with a skin material, a method for efficiently producing a multilayer molded article having a uniform surface and an excellent outer appearance while preventing damage in the skin material and preventing luster variations or wrinkles on a resin surface which is not laminated with the skin material.

It is still another object of the present invention to provide a mold assembly used for the method for the present invention.

The present invention provides a method for producing a thermoplastic resin molded article, which comprises the steps of:

(a) supplying a first molten thermoplastic resin from a first resin-supplying gate to a first portion of a cavity formed between a cavity face of a first mold and a cavity face of a second mold, said first and second molds being in an open state;
(b) closing said first mold and said second mold to set the cavity in a closed state;
(c) injecting a second molten thermoplastic resin from a second resin-supplying gate to a second portion of the cavity in the closed state;
(d) cooling and solidifying said first and second resins in the cavity in the closed state; and
(e) opening said first mold and said second mold to remove said molded article.

Further, the present invention provides a method for producing a thermoplastic resin molded article partially laminated with a skin material, which comprises the steps of:

(a) arranging a skin material in a first portion of a cavity formed between a cavity face of a first mold and a cavity face of a second mold, and supplying a first molten thermoplastic resin from a first resin-supplying gate to the first portion of the cavity (preferably a portion between the skin material and at least one cavity face of the cavity faces of the first and second molds), said first and second molds being in an open state;
(b) closing said first mold and said second mold to set the cavity in a closed state;
(c) injecting a second molten thermoplastic resin from a second resin-supplying gate to a second portion of the cavity in the closed state;
(d) cooling and solidifying said first and second resins in the cavity in the closed state; and
(e) opening said first mold and said second mold to remove said molded article.

One aspect of the method of the present invention further comprises the steps of:

(f) causing a movable dam arranged in at least one mold of said first mold and said second mold to project from a cavity face of said mold into the cavity in the open state before said first molten thermoplastic resin is supplied, thereby partitioning the cavity into the first portion and the second portion; and
(g) returning said movable dam into said mold before injection of the second resin.

In the method of the present invention, it is preferable that the first and second molds are closed at a closing pressure of 30 to 90 kgf/cm^2, and the second resin is injected to the second portion of the cavity at a closing pressure of 100 to 400 kgf/cm^2. Further, it is preferable that injection of the second resin is started 0 to 30 second after the first resin is completely supplied.

In the method of the present invention, a molded article having an excellent outer appearance can be obtained while preventing luster variations or wrinkles called charge marks at at least an injection-molded portion because not all portions of the resulting article have been molded by press molding. Since injection molding is partially used together with press molding, a high pressurizing force is not required unlike a conventional injection molding method, so the apparatus does not become bulky. Additionally, according to the present invention, it becomes possible to produce efficiently and easily a resin molded article in which a press-molded portion is sufficiently integrated, or in one piece, with an injection-molded portion.

Even when a resin molded article partially laminated with a skin material is to be produced, a decrease in grain patterns formed on the surface of the skin material or damage in skin material can be prevented because the pressing force of the molten resin is not so high, and the skin material is not positionally shifted. In addition, a molded article having an excellent outer appearance at at least an injection-molded portion, in which a press-molded portion is sufficiently integrated with the injection-molded portion, can be obtained.

When a movable dam is used, the press-molded portion and the injection-molded portion of the obtained molded article can be clearly distinguished from each other, and outflow of the first molten resin to the second portion to-be injection-molded is prevented in press molding. For this reason, a high-quality thermoplastic resin molded article which is satisfactorily integrated and has a sharp boundary between the press-molded portion and the injection-molded portion can be produced. In addition, when the movable dam is used, the positional shift of the skin material can be certainly prevented.

The present invention provides a mold assembly for molding a thermoplastic resin, which comprises:

a first mold having a cavity face;

a second mold having a cavity face opposing said cavity face of said first mold;

a first resin-supplying unit for supplying a first molten thermoplastic resin to a first portion of a cavity formed between said cavity face of said first mold and said cavity face of said second mold;

a second resin-supplying unit for supplying a second molten thermoplastic resin to a second portion of the cavity;

a press unit, connected to said first and second molds, for moving at least one of said molds between an open position where said first and second molds are in an open state and a closed position where said molds are in a closed state and maintaining said first and second molds at a predetermined closing pressure; and

a control unit connected to said press unit and said first and second resin-supplying units, said control unit driving said first resin-supplying unit for a first period of time to supply said first resin while said first and second molds are maintained in the open state by said press unit, driving said press unit to close said first and second molds at a first closing pressure and set said molds in the closed state while or after said first resin is supplied, driving said second resin-supplying unit for a second period of time to inject said second resin while maintaining said first and second molds at a second closing pressure after completion of closing of said molds, and driving said press unit to open said first and second molds after a third period of time elapses from completion of injection of said second resin.

Further, the present invention provides a mold assembly for molding a thermoplastic resin, which comprises:

a first mold having a cavity face and a groove communicating with said cavity face;

a second mold having a cavity face opposing said cavity face of said first mold;

a movable dam received in the groove;

a dam driving unit for moving said movable dam between a first position where said movable dam is completely received into said first mold and a second position where a part of said movable dam projects from said cavity face of said mold to partition a cavity formed between said cavity face of said first mold and said cavity face of said second mold into a first portion and a second portion;

a first resin-supplying unit for supplying a first molten thermoplastic resin to said first portion of the cavity;

a second resin-supplying unit for supplying a second molten thermoplastic resin to said second portion of the cavity;

a press unit, connected to said first and second molds, for moving at least one of said molds between an open position where said first and second molds are in an open state and a closed position where said molds are in a closed state and maintaining said first and second molds at a predetermined closing pressure; and

a control unit connected to said press unit, said first and second resin-supplying units, and said dam driving unit, said control unit driving said dam driving unit to cause said part of said movable dam to project into the cavity, driving said first resin-supplying unit for a first period of time to supply said first resin while said first and second molds are maintained in the open state by said press unit, driving said press unit to close said first and second molds at a first closing pressure and set said molds in the closed state while or after said first resin is supplied, driving said dam driving unit in a manner interlocked with closing of said first and second molds to return said movable dam into said mold, driving said second resin-supplying unit for a second period of time to inject said second resin while maintaining said first and second molds at a second closing pressure after completion of closing of said molds, and driving said press unit to open said first and second molds after a third period of time elapses from completion of injection or said second resin.

The mold assembly of the present invention preferably further comprises a position detection unit, con-

nected to the control unit, for detecting a position of at least one of the first and second molds.

The above-mentioned "open state" is defined as a state wherein a cavity clearance between the cavity face or a first mold and the cavity face of a second mold is larger than the thickness of a desired product (thermoplastic molded article). In the present invention, the open state preferably includes a first open state wherein the molds are arranged with a cavity clearance therebetween such that the molded article between the first and second molds can be removed, and a second open state wherein the cavity clearance is smaller than that in the first open state. According to an aspect of the mold assembly of the present invention, the control unit drives a press unit before supply of a first resin, thereby shifting the first and second molds from the first open state to the second open state.

By using the mold assembly of the present invention, the method of the present invention can be simply and efficiently performed.

The present invention will be more fully understood from the detailed description given hereinbelow and the accompanying drawings, which are given by way or illustration only and are not to be considered as limiting the present invention.

Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will be apparent to those skilled in the art from this detailed description.

Fig. 1 is a sectional view schematically showing an example of the mold assembly of the present invention;

Fig. 2 is a sectional view schematically showing another example of the mold assembly of the present invention;

Fig. 3 is a sectional view schematically showing still another example of the mold assembly of the present invention;

Fig. 4 is a timing chart showing the operations of a second mold and a resin-supplying gate in an example of the method of the present invention;

Fig. 5 is a timing chart showing the operations or the second mold and the resin-supplying gate in another example of the method of the present invention;

Fig. 6 is a timing chart showing the operations of the second mold and the resin-supplying gate in still another example of the method of the present invention;

Fig. 7 is a perspective view showing an example of a thermoplastic resin molded article produced by the method of the present invention;

Fig. 8 is a sectional view taken along a line X - X of the molded article shown in Fig. 7;

Figs. 9 to 12 are sectional views each of which schematically shows the state in one producing step of the method of the present invention, in which the molded article shown in Fig. 7 is produced using the mold assembly shown in Fig. 1 in accordance with the timing chart shown in Fig. 4;

Fig. 13 is a timing chart showing the operations of the second mold, the resin-supplying gate, and a movable dam in still another example of the method of the present invention;

Figs. 14 to 17 are sectional views each of which schematically shows the state in one producing step of the method of the present invention, in which the molded article shown in Fig. 7 is produced using the mold assembly shown in Fig. 3 in accordance with the timing chart shown in Fig. 13;

Fig. 18 is a perspective view showing an example of a thermoplastic resin molded article partially laminated with a skin material, which is produced by the method of the present invention;

Fig. 19 is a sectional view taken along a line Y - Y of the molded article shown in Fig. 18;

Figs. 20 to 24 are sectional views each of which schematically shows the state in one producing step of the method of the present invention, in which the molded article shown in Fig. 18 is produced using the mold assembly shown in Fig. 1 in accordance with the timing chart shown in Fig. 4; and

Figs. 25 to 29 are sectional views each of which schematically shows the state in one producing step of the method of the present invention, in which the molded article shown in Fig. 18 is produced using the mold assembly shown in Fig. 3 in accordance with the timing chart shown in Fig. 13.

The present invention will be described below with reference to the accompanying drawings. The same reference numerals throughout the drawings denote the same parts.

The mold assembly of the present invention, which is used to mold a thermoplastic resin, will be described.

The mold assembly of the present invention is constituted by a first mold 1a and a second mold 1b, as shown in Fig. 1. The molds are attached to a press unit 2. Referring to Fig. 1, the first mold 1a is fixed to a fixed frame 2a of the press unit 2 (the first mold 1a being a fixed mold). The second mold 1b is fixed to a movable frame 2c connected to the fixed frame 2a through a connecting rod 2b (the second mold 1b being a movable mold). A driving unit 2d of the second mold 1b is connected to the movable frame 2c, so that the second mold 1b can be moved in a direction indicated by an arrow A in Fig. 1. The driving unit 2d of the second mold 1b is not particularly limited. For example, a hydraulic driving unit is used.

The first mold 1a and the second mold 1b respectively have cavity faces 3a and 3b opposing each other and corresponding to the shape of a desired product. When the first mold 1a and the second mold 1b are

closed, the cavity faces 3a and 3b define a cavity substantially coinciding with the outer shape of the desired molded article.

The second mold 1b can be moved, by the press unit 2, among (i) a first open position where a cavity clearance (B in Fig. 1) between the cavity face 3a of the first mold and the cavity face 3b of the second mold is maintained in a state (first open state) wherein the molded article between the first and second molds 1a and 1b can be removed, (ii) a second open position where the cavity clearance is maintained in a state (second open state) to be smaller than that in the first open state, and (iii) a closed position where the cavity clearance is maintained in a state (closed state) to substantially match the thickness of the desired molded article. The first and second molds 1a and 1b can be maintained at a predetermined closing pressure by the press unit 2. Note that the first and second molds 1a and 1b shown in Fig. 1 are in the first open state.

The first mold 1a shown in Fig. 1 is a so-called male mold whose cavity face 3a is formed as a projecting portion. The second mold 1b is a so-called female mold whose cavity face 3b is formed as a recessed portion. However, the second mold may be a male mold while the first mold may be a female mold. In addition, the first mold may be a movable mold while the second mold may be a fixed mold, or both the molds may be movable molds. Furthermore, the first mold may be an upper mold while the second mold may be a lower mold.

The cavity face 3a of the first mold 1a has at least one first resin-supplying gate 4a open to a first portion where a first molten thermoplastic resin to be press-molded is supplied, and at least one second resin-supplying gate 4b open to a second portion where a second molten thermoplastic resin to be injection-molded is supplied. First and second gate opening/closing means 5a and 5b are respectively arranged around the first and second resin-supplying gates 4a and 4b to independently control closing/opening of the first and second resin-supplying gates 4a and 4b. Note that the gate opening/closing means can be a mechanical means (e.g., shut-off pin) or a means (e.g., a shut-off heater) for melting or solidifying the resin near the gate. The number of first and second resin-supplying gates 4a and 4b is appropriately determined in accordance with the size of the first and second portions or the shape of the desired molded article.

A resin extruding unit 7 is connected to the first and second resin-supplying gates 4a and 4b through first and second resin passages 6a and 6b formed in the first mold 1a, respectively. A first resin-supplying unit is constituted by the first resin-supplying gate 4a, the first gate opening/closing means 5a, the first resin passage 6a, and the resin extruding unit 7. A second resin-supplying unit is constituted by the second resin-supplying gate 4b, the second gate opening/closing means 5b, the second resin passage 6b, and the resin extruding unit 7. The first and second resin passages 6a and 6b shown in Fig. 1 are integrated midway and connected to the single resin extruding unit 7. However, as shown in Fig. 2, the first and second passages 6a and 6b may be respectively connected to first and second resin extruding units 7a and 7b through the independently arranged first and second resin passages 6a and 6b.

A control unit (CPU) 8 is connected to the first and second gate opening/closing means 5a and 5b and the driving unit 2d of the press unit 2 to control these units. In the mold assembly of the present invention, the operations of the driving unit 2d of the press unit 2, and the first and second gate opening/closing means 5a and 5b, and the closing pressure of the first and second molds 1a and 1b are controlled by the control unit 8, as will be described later. It is preferable to control each unit upon detecting that the second mold 1b is set at a predetermined position with respect to the first mold 1a. In the mold assembly shown in Fig. 1, a position detection unit 9 for detecting the position of the second mold 1b is arranged along the side surfaces of the first and second molds 1a and 1b. The position detection unit 9 is also connected to the control unit 8. The position detection unit 9 is not particularly limited. For example, a means for, e.g., mechanically, electrically, or optically detecting the position of the second mold 1b is used. The period of time for opening the first and second resin-supplying gates 4a and 4b (period of time for driving the first and second resin-supplying units), the period or time from closing of the first resin-supplying gate 4a to opening of the second resin-supplying gate 4b, the period of time from closing the second resin-supplying gate 4b to driving of the driving unit 2d of the press unit 2, and the like are controlled by a timer 10 incorporated in the control unit 8.

The mold assembly of the present invention may have a movable dam for temporarily partitioning the first portion of the cavity, where the first molten thermoplastic resin is to be supplied, from the second portion of the cavity, where the second molten thermoplastic resin is to be supplied. Fig. 3 shows the mold assembly of the present invention, which has such a movable dam.

The first mold 1a of the mold assembly shown in Fig. 3 has a groove 11 communicating with the cavity face 3a. A movable dam 12 is received in the groove 11. The lower end portion of the movable dam 12 is connected to a dam driving unit 13 arranged in the first mold 1a. The movable dam 12 can be moved (slid) by the dam driving unit 13 in a direction C shown in Fig.3. Although the direction C shown in Fig.3 is substantially parallel to the mold opening/closing direction A, such a direction C may not be parallel to the direction A. With this operation, the movable dam 12 can be moved between the first position where the movable dam 12 is completely received in (put into) the first mold 1a and the second position where a part (upper end portion) of the movable dam 12 projects from the cavity face 3a. Note that the movable dam 12 shown in Fig. 3 is at the second position. The movable dam 12 preferably has an upper surface substantially parallel to the cavity face 3a such that the distal end surface (upper end surface) of the movable dam 12 at the

first position forms a single plane together with the cavity face 3a. In addition, the movable dam 12 preferably has almost the same width as that of the groove 11 not to substantially form a gap between the side surface (sliding surface) of the movable dam 12 and the inner surface (sliding surface) of the groove 11 in the first mold 1a. Note that the dam driving unit 13 is not particularly limited. For example, a driving unit using an air or hydraulic pressure, or an electromagnetic driving unit is used.

As described above, in the mold assembly shown in Fig. 3, the movable dam 12 is provided at the boundary between the press-molded portion (first portion where the first resin to be press-molded is to be supplied) and the injection-molded portion (second portion where the second resin to be injection-molded is to be supplied). The movable dam 12 can be slid in the first mold 1a by the dam driving unit 13 in the mold opening/closing direction C so as to project into the cavity. The movable dam 12 may be provided in the second mold or in both the molds.

The movable dam 12 may be continuously or discontinuously provided at the boundary between the press-molded portion and the injection-molded portion. When the press-molded portion is at the central portion of the desired molded article, and the entire peripheral portion of the press-molded portion is surrounded by the injection-molded portion, the movable dam at the boundary is preferably continuous. When the end portion of the press-molded portion corresponds to part of the end portion of the desired molded article, the movable dam may be provided at only a portion where the press-molded portion is in contact with the injection-molded portion. The continuous movable dam here must be only apparently continuous, as a matter of course. As for the structure, the movable dam may be divided into units of predetermined lengths suitable for sliding.

A length (D in Fig. 3) of the portion of the movable dam 12, which projects into the cavity in the mold opening/closing direction C, must be larger than a thickness F (final product thickness) of the desired molded article. However, when the movable dam 12 excessively projects beyond the thickness of the molded article, the mold excessively becomes thicker accordingly, or the strength of the movable dam 12 must be excessively increased. Therefore, the length D is normally smaller than 15 times the final product thickness, and preferably smaller than 10 times the final product thickness.

The dam driving unit 13 is also connected to the control unit (CPU) 8 together with the first and second gate opening/closing means 5a and 5b and the driving unit 2d of the press unit 2. In the mold assembly of the present invention shown in Fig. 3, the operations of the driving unit 2d of the press unit 2, the dam driving unit 13, and the first and second gate opening/closing means 5a and 5b, and the closing pressure of the first and second molds 1a and 1b are controlled by the control unit 8, as will be described later.

As shown in Figs. 1 to 3, the mold assembly of the present invention may have a skin material conveying means 14 in addition to the above arrangement. The skin material conveying means 14 shown in Figs. 1 to 3 can move in a direction indicated by an arrow E in Figs. 1 to 3 while holding a skin material, thereby arranging the skin material at a predetermined position (preferably at the first portion of the cavity) on the cavity face 3a of the first mold 1a in the open state (preferably in the first open state). When the skin material conveying means 14 is arranged, the skin material conveying means 14 is also connected to the control unit (CPU) 8 together with the first and second gate opening/closing means 5a and 5b, and the driving unit 2d of the press unit 2. In the mold assembly of the present invention shown in Figs. 1 to 3, the operations of the driving unit 2d of the press unit 2 and the skin material conveying means 14, and the closing pressure are controlled by the control unit 8, as will be described later. Note that the detailed structure of the skin material conveying means 14 is not particularly limited.

The method of the present invention in which the mold assembly of the present invention is used to produce a thermoplastic resin molded article, and the control sequence of the control unit in the mold assembly of the present invention will be described below.

The method of producing a thermoplastic resin molded article shown in Figs. 7 and 8 by using the mold assembly shown in Fig. 1 will be described below with reference to timing charts shown in Figs. 4 to 6. Figs. 9 to 12 are sectional views schematically showing the molds in molding steps in an embodiment of the producing method of the present invention.

Fig. 7 is a perspective view showing an example or a thermoplastic resin molded article 15 obtained by the method of the present invention. Fig. 8 is a longitudinal sectional view taken along a line X - X of the molded article in Fig. 7. A portion surrounded by a dotted line 16 in Fig. 7 is a portion 15a molded by press molding (portion molded at the first portion in the cavity) while the remaining portion is a portion 15b molded by injection molding (portion molded at the second portion in the cavity).

As shown in Fig. 4, the control unit 8 drives the driving unit 2d to lower the second mold 1b from the first open position to the second open position shown in Fig. 9 (t_1 to t_2). Note that the cavity clearance B in the first open state is normally 500 to 1,500 mm, and the cavity clearance B in the second open state is normally (thickness of desired molded article) + 0.1 to 50 mm. In the second open state wherein the cavity clearance between the two molds is larger than the final product thickness F, the first gate opening/closing means 5a is kept open during a first period of time (t_3 to t_4). With this operation, of the total amount of the molten thermoplastic resin to be supplied, the first molten thermoplastic resin 15a in a necessary amount (first amount) for forming the press-molded portion of the final molded article is supplied from the first resin-supplying gate 4a to the first portion of the cavity race 3a, where the resin is press-molded (Fig. 9). Subsequently, the driving unit 2d is driven to close the second mold 1b from the second open position to the

closed position shown in Fig. 10 at the first closing pressure (t_5 to t_6). With this operation, the first resin 15a is press-molded, the cavity including the resin unsupplied portion (portion where the resin is injection-molded: second portion) is set in a closed state, and the cavity clearance B matches the final product thickness F. The first closing pressure is preferably 30 to 90 kgf/cm^2.

The closing operation may be performed after the first resin in the necessary amount (first amount) is completely supplied, as shown in Fig. 4. Alternatively, as shown in Fig. 5, the closing operation may be started while the first resin is being supplied. In this case, the closing operation is finished upon completion of supply of the first molten resin in the necessary amount. Supply of the first resin and the closing operation can be started at any timing as far as the first resin in the necessary amount is completely supplied when or before the cavity clearance B matches the final product thickness F.

Upon completion of the closing operation, the second gate opening/closing means 5b is kept open during the second period of time (t_7 to t_8) while the first and second molds 1a and 1b are held at the second closing pressure, and the cavity clearance B is held at the final product thickness F. With this operation, the second molten thermoplastic resin 15b in the remaining amount (second amount) is injected from the second resin-supplying gate 4b to the resin unsupplied portion (second portion) in the closed state (Fig. 11), thereby filling the cavity with the first and second resins 15a and 15b (Fig. 12). The second closing pressure is preferably 100 to 400 kgf/cm^2. In the method of the present invention, injection of the second resin 15b (t_7) is started preferably 0 to 30 seconds, and more preferably 0 to 10 seconds after the first resin 15a is completely supplied (t_4). With this operation, the press-molded first resin 15a and the injection-molded second resin 15b are satisfactorily integrated with each other.

In injection of the second molten resin 15b, the cavity clearance B need not always be strictly "held" at the final product thickness F unless the cavity clearance B is smaller than the final product thickness F. For example, when the second resin is to be injected, the dwell pressure of the two molds 1a and 1b may be reduced. Alternatively, as shown in Fig. 6, the molds 1a and 1b may be slightly opened (preferably to such a degree that the second resin injected will not flow into the first portion (the press-molded portion))by the resin injection pressure, and the closing operation may be performed again until the final product thickness F is set after the second resin is completely supplied. Injection in the present invention also includes these embodiments.

Upon completion of injection molding of the second resin 15b, the molds 1a and 1b are held in a state shown in Fig. 12 during the third period of time, thereby cooling and solidifying the molten thermoplastic resins 15a and 15b. Thereafter, the driving unit 2d is driven to move the second mold 1b from the closed position to the first open position, thereby opening the molds. With this operation, the molded article can be removed (t_9).

In the method of the present invention, by using the mold assembly as shown in Fig. 2, a resin different from the first resin to be supplied to the first portion (press-molded portion) may be used as the second resin to be supplied to the second portion (injection-molded portion), or different resins may be supplied from the resin-supplying gates 4a and 4b, respectively, thereby to obtain a multicolor molded article having two or more colors.

A method in which the mold assembly shown in Fig. 3 is used to produce the thermoplastic resin molded article shown in Figs. 7 and 8 will be described below with reference to a timing chart shown in Fig. 13. Figs. 14 to 17 are sectional views schematically showing the molds in molding steps in an embodiment of the producing method of the present invention.

As shown in Fig. 13, the control unit 8 drives the dam driving unit 13 to move the movable dam 12 from the first position to the second position, thereby causing part of the movable dam 12 to project into the cavity in the first open state (T_1). At this time, the length D of the portion of the movable dam 12, which projects in the cavity, is larger than the final product thickness F. The driving unit 2d is driven to lower the second mold 1b from the first open position to the second open position shown in Fig. 14 (T_2 to T_4). After the cavity face 3b of the second mold 1b is brought into contact with the movable dam 12, the movable dam 12 is also moved from the uppermost position to the upper position in a manner interlocked with the second mold 1b (T_3 to T_4). Therefore, the upper end surface of the movable dam 12 is in contact with the cavity face 3b of the second mold 1b.

The first gate opening/closing means 5a is kept open during the first period of time (T_5 to T_8). With this operation, the first molten thermoplastic resin 15a in a necessary amount (first amount) for forming the press-molded portion is supplied from the first resin-supplying gate 4a to the cavity face (first portion) surrounded by the movable dam 12 (Fig. 14). The driving unit 2d of the press unit 2 and the dam driving unit 13 are driven to close the second mold 1b from the second open position to the closed position shown in Fig. 15 at the first closing pressure while pushing down the movable dam 12 (T_7 to T_8). With this operation, the first resin 15a is press-molded, and the cavity clearance B matches the final product thickness F.

In this case as well, the closing operation may be performed after the first resin is completely supplied. Alternatively, the closing operation may be started while the first resin is supplied, and the movable dam 12 is pushed down. In this case, the closing operation is finished upon completion of supply of the first molten resin in a necessary amount.

Upon completion of the closing operation, the dam driving unit 13 is driven to return (retreat or put) the movable dam 12 into the first mold 1a (T_8 to T_9). At this time, the distal end surface of the movable dam 12 must match the cavity face 3a of the first mold 1a to form a smooth surface. If the movable dam 12 is insufficiently or exces-

sively returned, three-dimensional patterns are formed on the obtained molded article at a position corresponding to the movable dam.

After the movable dam 12 is completely returned, the second molten thermoplastic resin 15b is injected into the remaining cavity (second portion), as shown in Fig. 16 (T_{10} to T_{11}), thereby filling the cavity with the first and second resins 15a and 15b (Fig. 17), as in the above embodiment. After the second resin 15b is injection-molded, as in the above embodiment, the molten thermoplastic resins 15a and 15b are cooled and solidified, and the molded article is removed from the molds (T_{12}).

The method of producing a resin molded article not laminated with a skin material has been described above. According to the method of the present invention, a resin molded article laminated with a skin material can also be produced. A method of producing a thermoplastic resin molded article shown in Figs. 18 and 19 by using a mold assembly which is the same as that in Fig. 1 except for the shapes of the cavity faces 3a and 3b and the arrangement of the resin-supplying gates 4a and 4b will be described below with reference to the timing chart shown in Fig. 4. Figs. 20 to 24 are sectional views schematically showing the molds in molding steps in an embodiment or the producing method of the present invention.

Fig. 18 is a perspective view showing an example of the thermoplastic resin molded article 15 laminated with a skin material obtained by the method of the present invention. Fig. 19 is a longitudinal sectional view taken along a line Y - Y of the molded article in Fig. 18. The lower portion of a skin material 17 shown in Fig. 19 corresponds to the press-molded portion 15a (portion molded at the first portion of the cavity), and the remaining portion corresponds to the injection-molded portion 15b (portion molded at the second portion of the cavity).

When the area (second portion) not laminated with the skin material 17 is divided by the skin material laminated area (first portion) into two or more portions, at least one second resin-supplying gate 4b is required on the cavity face corresponding to each non-laminated area. Similarly, when the skin material laminated area (first portion) is distributed to two or more portions, at least one first resin-supplying gate 4a is required on the cavity face corresponding to each skin material laminated area.

As shown in Fig. 4, the control unit 8 drives the skin material conveying means 14 to place the skin material 17 which is cut into a predetermined size at a predetermined position in the cavity between the first and second molds 1a and 1b in the first open state such that the lower surface of the skin material 17 is brought into contact with the cavity face 3a of the first mold (Fig. 20). The driving unit 2d is driven to lower the second mold 1b from the first open position to the second open position shown in Fig. 21 (t_1 to t_2). When the skin material is used, the cavity clearance B in the second open state is normally (thickness of desired molded article (base material portion)) + 5 to 100 mm.

In the second open state wherein the cavity clearance B is larger than the final product thickness F, the first gate opening/closing means 5a is kept open during the first period of time (t_3 to t_4). With this operation, the first molten thermoplastic resin 15a is supplied between the skin material 17 and the cavity face 3a of the first mold 1a (Fig. 21). The driving unit 2d is driven to close the second mold 1b from the second open position to the closed position shown in Fig. 22 at the first closing pressure (t_5 to t_6). With this operation, the first resin 15a is press-molded together with the skin material 17. At the same time, the cavity including the resin unsupplied portion (non-laminated area: second portion) is set in the closed state, and the cavity clearance B matches the final product thickness F.

The amount of the first molten thermoplastic resin 15a supplied at this time corresponds to, of the total amount of the molten thermoplastic resin to be finally supplied, at least the amount of the resin forming the base material portion laminated with the skin material 17. The specific supply amount changes depending on the ratio of the portion laminated with the skin material 17 to the molded article or the shape of the molded article. The amount is normally twice by weight the calculated resin amount of the base material portion or less, preferably 1.5 times or less by weight, and more preferably 1.3 times or less by weight.

Upon completion of the closing operation, the second gate opening/closing means 5b is kept open during the second period of time (t_7 to t_8) while first and second molds 1a and 1b are held at the second closing pressure, and the cavity clearance B is held at the final product thickness F. With this operation, the second molten thermoplastic resin 15b in the remaining amount (second amount) is injected from the second resin-supplying gate 4b to the resin unsupplied portion (area not laminated with skin material: second portion) in the closed state (Fig. 23), thereby filling the cavity with the first and second resins 15a and 15b (Fig. 24). With this operation, the portion not laminated with the skin material 17 is injection-molded.

When the non-laminated area (second portion) is divided by the skin material laminated area (first portion) into two or more portions, the second molten resin 15b is distributed to each area in accordance with the resin amount required by each area. At this time, the distribution amount of the resin to be supplied is calculated in accordance with the volume to be filled with the resin. However, when the non-laminated area is not completely divided, i.e, when two or more areas communicate with each other, the distribution amount need not always be strictly calculated because the molten thermoplastic resin before cooling/solidifying has a fluidity.

After the second resin 15b is completely injection-molded, the molds 1a and 1b are held in the state shown in Fig. 24 during the third period of time, and the molten thermoplastic resins 15a and 15b are cooled and solidified. Thereafter, the driving unit 2d is driven to move the second mold 1b from the closed position to the first open

position, thereby opening the molds. With this operation, the molded article can be removed (t_9).

In the method of the present invention, a resin different from the first resin to be supplied to the skin material laminated area (first portion) may be used as the second resin to be supplied to the non-laminated area (second portion), or different resins may be supplied from the resin-supplying gates 4a and 4b, respectively, thereby to obtain a multicolor molded article having two or more colors.

A method of producing the thermoplastic resin molded article shown in Figs. 18 and 19 by using a mold assembly which is the same as that shown in Fig. 3 except for the shapes of the cavity faces 3a and 3b and the arrangement of the resin-supplying gates 4a and 4b will be described below with reference to the timing chart shown in Fig. 13. Figs. 25 to 29 are sectional views schematically showing the molds in molding steps in an embodiment of the producing method of the present invention.

As shown in Fig. 13, the control unit 8 drives the dam driving unit 13 to move the movable dam 12 from the first position to the second position, thereby causing part of the movable dam 12 to project into the cavity in the first open state (T_1). At this time, the length D of the portion of the movable dam 12, which projects in the cavity, is larger than the final product thickness F. The control unit 8 drives the skin material conveying unit 14 to place the skin material 17 which is cut into a predetermined size at a predetermined position in the cavity between the first and second molds 1a and 1b in the first open state such that the lower surface of the skin material 17 is brought into contact with the cavity face 3a of the first mold (Fig. 25). In this case, it is preferable that the skin material 17 is arranged such that an edge portion of the skin material 17 is set along the movable dam 12. The driving unit 2d is driven to lower the second mold 1b from the first open position to the second open position shown in Fig. 26 (T_2 to T_4). After the cavity face 3b of the second mold 1b is brought into contact with the movable dam 12, the movable dam 12 is also moved from the uppermost position to the upper position in a manner interlocked with the second mold 1b (T_3 to T_4). Therefore, the upper end surface of the movable dam 12 is in contact with the cavity face 3b of the second mold 1b.

The first gate opening/closing means 5a is kept open during the first period of time (T_5 to T_6). With this operation, the first molten thermoplastic resin 15a in an amount (first amount) corresponding to the amount of the resin forming the base material portion to be laminated with the skin material is supplied from the first resin-supplying gate 4a between the skin material 17 and the cavity face 3a of the first mold in the space (first portion) surrounded by the movable dam 12 (Fig. 26). The driving unit 2d of the press unit 2 and the dam driving unit 13 are driven, thereby closing the second mold 1b from the second open position to the closed position shown in Fig. 27 at the first closing pressure while pushing down the movable dam 12 (T_7 to T_8). With this operation, the first resin 15a is press-molded together with the skin material 17, and the cavity clearance B matches the final product thickness F. In this closing process, positional shift of the skin material 17 is prevented by the movable dam 12. In addition, outflow of the supplied first molten resin into the remaining cavity is also prevented.

Upon completion of the closing operation, the dam driving unit 13 is driven to return the movable dam 12 into the first mold 1a (T_8 to T_9). After the movable dam 12 is completely returned, the second molten thermoplastic resin 15b is injected into the remaining cavity (second portion) corresponding to the non-laminated area as shown in Fig 28 (T_{10} to T_{11}), as in the above embodiment, thereby filling the cavity with the first and second resins 15a and 15b (Fig. 29). With this operation, the portion not laminated with the skin material 17 is injection-molded.

After the second resin 15b is injection-molded, the molten thermoplastic resins 15a and 15b are cooled and solidified, and the molded article is removed from the molds (T_{12}), as in the above embodiment.

As the resin used in the present invention, any resin normally used in press molding, injection molding, and extrusion molding can be used. For example, a general thermoplastic resin such as polypropylene, polyethylene, an acrylonitrile-styrene-butadiene block copolymer, polystyrene, polyamide including nylon, polyvinyl chloride, polycarbonate, an acrylic resin, polyacrylate or a copolymer of acrylate, or a styrene-butadiene block copolymer; a thermoplastic elastomer such as EPM or EPDM; a mixture thereof; or a polymer alloy using the above materials can be used. The thermoplastic resin used in the present invention may be foamable or non-foamable.

The thermoplastic resin may contain normally used glass fibers or various fillers such as inorganic and organic fillers, as needed. As a matter of course, the thermoplastic resin may contain various additives such as various pigments, lubricants, antistatic agents, and stabilizers normally used.

As the skin material, conventionally known various skin materials such as various woven or non-woven fabrics, a knitted fabric, a sheet or film of a thermoplastic resin or elastomer, paper, a metal foil, a net, or a foamed thermoplastic resin or elastomer sheet can be used. In accordance with the application purpose, the surface of the skin material may be decorated with three-dimensional patterns (such as grain patterns), printing, dyeing, and the like.

Not only a single skin material but also a composite skin material consisting of a laminate of two or more materials which are bonded to each other with an adhesive or the like can be used. Particularly, a polyvinyl chloride sheet using, as a backing material, a foamed sheet such as a foamed polypropylene sheet, or a thermoplastic elastomer sheet such as EPDM is preferably used.

To use these skin materials, preheating may be performed to increase the adhesive properties between the skin material and the thermoplastic resin, or preshaping

may be performed in accordance with the shape of the area to-be laminated with the skin material.

As described above, according to the producing method of the present invention, even a large thermoplastic resin molded article can be produced at a relatively low pressure without making the apparatus bulky. In addition, a resin molded article having a uniform surface and an excellent outer appearance can be efficiently and easily produced while preventing luster variations or wrinkles at a portion of the surface of a desired molded article, which portion requires an excellent outer appearance or has a designed surface.

Further, according to the producing method of the present invention, even when a multilayer molded article partially laminated with a skin material is to be produced, a multilayer molded article having a uniform surface and an excellent outer appearance can be produced while laminating the skin material at a predetermined position without any positional shift and preventing damage to the skin material and luster variations or wrinkles at a resin portion not laminated with the skin material.

[Examples]

The present invention will be described below in more detail in accordance with examples. However, the present invention is not limited to these examples, as a matter of course.

In Examples 1 and 2 and Comparative Examples 1 and 2, a polypropylene resin (Sumitomo Noblen BPZ5077 available from Sumitomo Chemical Co., Ltd.) was used as the thermoplastic resin.

In Examples 3 and 4 and Comparative Examples 3 and 4, the following skin material and thermoplastic resin were used:

Skin material: Composite skin material obtained by laminating a foamed 3-mm thick polypropylene sheet having an expansion ratio of 15 times on the lower surface of a 0.6-mm thick olefin-based thermoplastic elastomer sheet with grain patterns

Thermoplastic resin: A polypropylene resin available from Sumitomo Chemical Co., Ltd. (Sumitomo Noblen BPZ5077)

Example 1

A thermoplastic resin molded article shown in Figs. 7 and 8 (thickness (F): 2.5 mm, length: 400 mm, width: 350 mm, height of side wall portion: 10 mm) was produced using the mold assembly shown in Fig. 1 in accordance with the timing chart shown in Fig. 4 and the steps shown in Figs. 9 to 12.

In this example, the temperature of the supplied molten thermoplastic resin was 200°C, and the temperature of the molds was 40°C.

① The pair of molds comprising the movable second molds 1b and the fixed first mold 1a were shifted from the first open state wherein the cavity clearance B was 600 mm to the second open state wherein the cavity clearance B was 6 mm (t_1 to t_2). In the second open state, 250 g of the first molten thermoplastic resin 15a, which corresponded to 1.05 times the resin amount necessary for forming the press-molded portion were supplied from the first resin-supplying gate 4a through the first resin passage 6a in three seconds (t_3 to t_4) (Fig. 9).

② After the first molten thermoplastic resin 15a was supplied, the first resin-supplying gate 4a was closed. The second mold 1b was lowered and closed at a closing pressure of 50 kgf/cm² until the cavity clearance B became 2.5 mm (t_5 to t_6) (Fig. 10).

③ The second resin-supplying gate 4b was kept open while applying the closing pressure to maintain this state, and 350 g of the second molten thermoplastic resin 15b were injected into the remaining cavity in four seconds (t_7 to t_8) (Fig. 11), thereby filling the space between the molds with the two resins (Fig. 12). The time (t_4 to t_7) required from completion of supply of the first resin to the start of supply of the second resin was two seconds.

④ The molds were cooled for 30 seconds to cool and solidify the supplied molten resins 15a and 15b.

Thereafter, the molds were opened to remove the molded article (t_9).

The closing pressure required for the injection-molding at this time was 114 kgf/cm². The first and second resins were sufficiently integrated with each other. As for the outer appearance of the obtained molded article, the injection-molded portion requiring an excellent outer appearance was satisfactorily produced on its entire surface without any luster variation although luster variations were slightly observed at the resin-supplying gate portion of the press-molded portion.

Comparative Example 1

A molded article having the same shape as that in Example 1 was obtained following the same procedures as in Example 1 except that 600 g of the molten thermoplastic resin were supplied from all the resin-supplying gates 4a and 4b into the cavity while maintaining the cavity clearance B to 6 mm, the closing operation was performed until the cavity clearance B became 2.5 mm, and injection molding in the step ③ was omitted.

The closing pressure required at this time (press-molding) was 68 kgf/cm². However, the obtained molded article had luster variations at all the resin-supplying gate portions.

Comparative Example 2

A molded article having the same shape as that in Example 1 was obtained following the same procedures as in Example 1 except that the closing operation was performed until the cavity clearance B became 2.5 mm without supplying the first resin in the step ①, and 600

g of the molten thermoplastic resin were injected from all the resin-supplying gates 4a and 4b into the cavity in the closed state while maintaining the clearance.

The obtained molded article had an excellent outer appearance without luster variation. However, the closing pressure (injection-molding) was as high as 205 kgf/cm^2.

Example 2

A thermoplastic molded article shown in Figs. 7 and 8 was produced using the mold assembly shown in Fig. 3 in accordance with the timing chart shown in Fig. 13 and the steps shown in Figs. 14 to 17.

In this example, the used thermoplastic resin, the temperature of the supplied thermoplastic resin, the temperature of the molds, and the shape of the molded article were the same as those in Example 1.

① The pair of molds comprising the movable second mold 1b and the fixed first mold 1a were set in the first open state wherein the cavity clearance B was 600 mm, and the movable dam 12 was caused to project such that the distal end thereof projected from the cavity face 3a by 10 mm (T_1).

② While pushing down the movable dam 12, the second mold 1b was lowered and set in the second open state wherein the cavity clearance B was 6 mm (T_2 to T_4), and 250 g of the first molten thermoplastic resin 15a, which corresponded to 1.05 times by weight the resin amount necessary for forming the press-molded portion, were supplied from the first resin-supplying gate 4a into a portion surrounded by the movable dam 12 through the first resin passage 6a in three seconds (T_5 to T_6) (Fig. 14).

③ After the first molten resin 15a was supplied, the first resin-supplying gate 4a was closed. The second mold 1b was further lowered and closed at closing pressure of 65 kgf/cm^2 while pushing down the movable dam 12 until the cavity clearance B became 2.5 mm (T_7 to T_8) (Fig. 15).

④ While maintaining this state, the movable dam 12 was returned into the mold until the distal end of the movable dam 12 matched the cavity face 3a of the first mold 1a (T_8 to T_9).

⑤ The second resin-supplying gate 4b was kept open while applying the closing pressure to maintain this state, and 350 g of the second molten thermoplastic resin 15b were injected into the remaining cavity in four seconds (T_{10} to T_{11}) (Fig. 16), thereby filling the space between the molds with the two resins (Fig. 17). The time (T_8 to T_{10}) required from completion of supply of the first resin to the start of supply of the second resin was two seconds.

⑥ The molds were cooled for 30 seconds to cool and solidify the supplied molten resins 15a and 15b. Thereafter, the molds were opened to remove the molded article(T_{12}).

The closing pressure required for the injection-molding at this time was 114 kgf/cm^2. The first and second resins were sufficiently integrated with each other. As for the outer appearance of the obtained molded article, the injection-molded portion requiring an excellent outer appearance was satisfactorily produced on its entire surface without any luster variation although luster variations were slightly observed at the resin-supplying gate portion of the press-molded portion.

Example 3

A multilayer molded article partially laminated with a skin material shown in Figs. 18 and 19 was produced using the mold assembly shown in Fig. 1 in accordance with the timing chart shown in Fig. 4 and the steps shown in Figs. 20 to 24.

In this example, the temperature of the supplied molten thermoplastic resin was 200°C, and the temperature of the molds was 40°C.

① The pair of molds comprising the movable second mold 1b and the fixed first mold 1a were set in the first open state wherein the cavity clearance B was 600 mm, and the skin material 17 cut into a predetermined size was placed such that the foamed sheet side was brought into contact with the cavity face 3a of the first mold (Fig. 20).

② The second mold 1b was lowered and set in the second open state wherein the cavity clearance B was 30 mm (t_1 to t_2), and the first molten thermoplastic resin 15a in an amount corresponding to 1.3 times by weight the resin amount of the base material portion to be laminated with the skin material and 35 wt% of the total thermoplastic resin to be supplied was supplied between the skin material 17 and the cavity face 3a of the first mold 1a from the first resin-supplying gate 4a through the first resin passage 6a in three seconds (t_3 to t_4) (Fig. 21).

③ After the first molten resin 15a was supplied, the first resin-supplying gate 4a was closed. The second mold 1b was lowered and closed at a closing pressure of 50 kgf/cm^2 until the cavity clearance B became 5 mm (t_5 to t_6) (Fig. 22).

④ The second resin-supplying gate 4b was kept open while applying the closing pressure to maintain this state, and the second molten thermoplastic resin 15b was injected into the space between the molds, which corresponded to the non-laminated area, in five seconds (t_7 to t_8) (Fig. 23), thereby filling the space between the molds with the two resins (Fig. 24). The time (t_4 to t_7) required from completion of supply of the first resin to the start of supply of the second resin was two seconds.

⑤ While maintaining this state, the molds were cooled for 30 seconds to cool and solidify the supplied molten resins 15a and 15b. Thereafter, the molds were opened to remove the molded article (t_9).

The produced multilayer molded article laminated with the skin material had an excellent outer appearance without any positional shift or breakage of the skin material and without any wrinkle or luster variation even at the skin material non-laminated portion. The closing pressure required for the injection-molding at this time was 114 kgf/cm^2. Further, the first and second resins were sufficiently integrated with each other.

Comparative Example 3

A molded article was obtained following the same procedures as in Example 3 except that, after the skin material 17 was placed such that the foamed sheet side was brought into contact with a predetermined cavity face 3a of the first mold 1a, the second mold 1b was lowered until the cavity clearance B became 5 mm without supplying the first molten resin, and, in this state, the total amount of the molten thermoplastic resin was injected from all the resin-supplying gates 4a and 4b into the cavity in the closed state.

The molding conditions including the used thermoplastic resin, the temperature of the supplied resin, the skin material, and the temperature of the molds were the same as those in Example 3.

The closing pressure (injection-molding) was as high as 205 kgf/cm^2. The obtained multilayer molded article was poor in outer appearance because the skin material was shifted from the predetermined position by positional shift, the grain patterns on the surface or the skin material were partially eliminated, and three-dimensional patterns were generated on the surface because of destruction of the foamed layer.

Comparative Example 4

A molded article was obtained following the same procedures as in Example 3 except that, after the skin material 17 was placed such that the foamed sheet side was brought into contact with a predetermined cavity face 3a of the first mold 1a, the second mold 1b was lowered until the cavity clearance B became 20 mm, and in this state, the total amount of the molten thermoplastic resin was supplied between the skin material 17 and the cavity face 3a of the first mold 1a from all the resin-supplying gates 4a and 4b, and the second mold 1b was lowered and closed until the cavity clearance a became 5 mm to perform press molding (without performing injection molding).

The molding conditions including the used thermoplastic resin, the temperature of the supplied resin, the skin material, and the temperature of the molds were the same as those in Example 3.

The skin material of the obtained molded article had an excellent outer appearance without positional shift. However, luster variations were generated on the surface of the resin portion not laminated with the skin material.

Example 4

A multilayer molded article partially laminated with the skin material shown in Figs. 18 and 19 was produced using the mold assembly shown in Fig. 3 in accordance with the timing chart shown in Fig. 13 and the steps shown in Figs. 25 to 29.

In this example, the used thermoplastic resin, the skin material, and the temperature of the supplied thermoplastic resin, and the temperature of the molds were the same as those in Example 3.

① The pair of molds comprising the movable second mold 1b and the fixed first mold 1a were set in the first open state wherein the cavity clearance B was 600 mm, and the movable dam 12 was caused to project such that the distal end thereof projected from the cavity face 3a by 35 mm (T_1).

② The skin material 17 cut into a predetermined size was placed on the portion surrounded by the movable dam 12 such that the foamed sheet side was brought into contact with the cavity face 3a (Fig. 25).

③ While pushing down the movable dam 12, the second mold 1b was lowered and set in the second open state wherein the cavity clearance B was 30 mm (T_2 to T_4), and the molten thermoplastic resin 15a in an amount corresponding to 1.05 times by weight the resin amount of the base material portion to be laminated with the skin material and 28 wt% of the total thermoplastic resin to be supplied was supplied from the first resin-supplying gate 4a into a space surrounded by the skin material 17, the movable dam 12 and the cavity face 3a through the first resin passage 6a for three seconds (T_5 to T_6) (Fig. 26).

④ After the first molten resin 15a was supplied, the first resin-supplying gate 4a was closed. The second mold 1b was further lowered and closed at a closing pressure of 65 kgf/cm^2 while pushing down the movable dam 12 until the cavity clearance B became 5 mm (T_7 to T_8) (Fig. 27).

⑤ While maintaining this state, the movable dam 12 was returned into the mold until the distal end of the movable dam 12 matched the cavity face 3a (T_8 to T_9).

⑥ While maintaining the closing pressure, the second resin-supplying gate 4b was opened to inject the second molten thermoplastic resin 15b into the remaining cavity, in five seconds (T_{10} to T_{11}) (Fig. 28), thereby filling the space between the molds with the two resins (Fig. 29). The time (T_6 to T_{10}) required from completion of supply of the first resin to the start of supply of the second resin was two seconds.

⑦ The molds were cooled for 30 seconds to cool and solidify the supplied molten resins 15a and 15b. Thereafter, the molds were opened to remove the molded article (T_{12}).

The produced multilayer molded article laminated with the skin material had an excellent outer appearance without any positional shift or breakage of the skin material and without any wrinkles and luster variation even at the skin material non-laminated area. The closing pressure required for the injection-molding at this time was 114 kgf/cm^2. Further, The first and second resins were sufficiently integrated with each other.

From the invention thus described, it will be obvious that the invention may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended for inclusion within the scope of the following claims.

The basic Japanese Applications No. 158496/1994 filed on July 11, 1994 and No. 166946/1994 filed on July 19, 1994 are hereby incorporated by reference.

Claims

1. A method for producing a thermoplastic resin molded article, comprising the steps of:

   (a) supplying a first molten thermoplastic resin from a first resin-supplying gate to a first portion of a cavity formed between a cavity face of a first mold and a cavity face of a second mold, said first and second molds being in an open state;
   (b) closing said first mold and said second mold to set the cavity in a closed state;
   (c) injecting a second molten thermoplastic resin from a second resin-supplying gate to a second portion of the cavity in the closed state;
   (d) cooling and solidifying said first and second resins in the cavity in the closed state; and
   (e) opening said first mold and said second mold to remove said molded article.

2. A method according to claim 1, wherein said thermoplastic resin molded article is constituted by a press-molded portion and an injection-molded portion,

   in the step (a), said first resin is supplied to said first portion of the cavity in the open state in a first amount necessary for forming said press-molded portion, of a total resin amount to be supplied into the cavity,

   in the step (b), said first resin is press-molded, and,

   in the step (c), said second resin is injected to said second portion of the cavity in the closed state in a second amount necessary for forming said injection-molded portion, and thereby, said second resin is injection-molded.

3. A method according to claim 1, further comprising the step of arranging a skin material in said first portion of the cavity in the open state before said first molten thermoplastic resin is supplied, and, wherein,

   in the step (a), said first resin is supplied from said first resin-supplying gate to said first portion of the cavity,

   in the step (b), said first mold and said second mold are closed to set the cavity in the closed state,

   in the step (c), said second molten thermoplastic resin is injected from said second resin-supplying gate to said second portion of the cavity in the closed state,

   in the step (d), said first and second resins are cooled and solidified in the cavity in the closed state, and,

   in the step (e), said first mold and said second mold are opened to remove said molded article.

4. A method according to claim 3, wherein said first resin is supplied between said skin material and at least one cavity face of said cavity faces of sad first and second molds.

5. A method according to claims 3 or 4, wherein said thermoplastic resin molded article is constituted by a press-molded portion and an injection-molded portion, and said skin material is laminated on at least a part of said press-molded portion,

   in the step (a), said first resin is supplied to said first portion of the cavity in the open state in a first amount necessary for forming said press-molded portion, of a total resin amount to be supplied into the cavity,

   in the step (b), said first resin is press-molded, and,

   in the step (c), said second resin is injected to said second portion of the cavity in the closed state in a second amount necessary for forming said injection-molded portion, and thereby, said second resin is injection-molded.

6. A method according to any one of claims 1 to 5, further comprising the steps of:

   (f) causing a movable dam arranged in at least one mold of said first mold and said second mold to project from a cavity face of said mold into the cavity in the open state before said first molten thermoplastic resin is supplied, thereby partitioning the cavity into said first portion and said second portion; and
   (g) returning said movable dam into said mold before injection of said second resin.

7. A method according to any one of claims 1 to 6, wherein said skin material is arranged in said first portion of the cavity such that an edge portion of said skin material is set along said movable dam.

8. A method according to any one of claims 1 to 7, wherein,

in the step (a), said first resin is supplied from said first resin-supplying gate which is arranged on at least one cavity face of said cavity faces of said first and second molds, and,

in the step (c), said second resin is injected from said second resin-supplying gate which is arranged on at least one cavity face of said cavity faces of said first and second molds.

9. A method according to any one of claims 1 to 8, wherein,

in the step (b), said first mold and said second mold are closed until a cavity clearance between said cavity face of said first mold and said cavity face of said second mold substantially matches a thickness of a desired molded article, and,

in the step (c), said second resin is injected to said second portion of the cavity while holding the cavity clearance.

10. A method according to any one of claims 1 to 9, wherein,

in the step (b), the first and second molds are closed at a closing pressure of 30 to 90 kgf/cm^2, and,

in the step (c), said second resin is injected to said second portion of the cavity at a closing pressure of 100 to 400 kgf/cm^2.

11. A method according to any one of claims 1 to 10, wherein injection of said second resin is started 0 to 30 second after said first resin is completely supplied.

12. A mold assembly for molding a thermoplastic resin, comprising:

a first mold having a cavity face;

a second mold having a cavity face opposing said cavity face of said first mold;

a first resin-supplying unit for supplying a first molten thermoplastic resin to a first portion of a cavity formed between said cavity face of said first mold and said cavity face of said second mold;

a second resin-supplying unit for supplying a second molten thermoplastic resin to a second portion of the cavity;

a press unit, connected to said first and second molds, for moving at least one of said molds between an open position where said first and second molds are in an open state and a closed position where said molds are in a closed state and maintaining said first and second molds at a predetermined closing pressure; and

a control unit connected to said press unit and said first and second resin-supplying units, said control unit driving said first resin-supplying unit for a first period of time to supply said first resin while said first and second molds are maintained in the open state by said press unit, driving said press unit to close said first and second molds at a first closing pressure and set said molds in the closed state while or after said first resin is supplied, driving said second resin-supplying unit for a second period of time to inject said second resin while maintaining said first and second molds at a second closing pressure after completion of closing of said molds, and driving said press unit to open said first and second molds after a third period of time elapses from completion of injection of said second resin.

13. A mold assembly according to claim 12, wherein the open state includes a first open state wherein said molds are arranged with a cavity clearance such that a molded article between said first and second molds can be removed, and a second open state wherein the cavity clearance is smaller than that in the first open state, and said control unit drives said press unit to shift said first and second molds from the first open state to the second open state, and thereafter, drives said first resin-supplying unit while maintaining said molds in the second open state.

14. A mold assembly for molding a thermoplastic resin, comprising:

a first mold having a cavity face and a groove communicating with said cavity face;

a second mold having a cavity face opposing said cavity face of said first mold;

a movable dam received in the groove;

a dam driving unit for moving said movable dam between a first position where said movable dam is completely received into said first mold and a second position where a part of said movable dam projects from said cavity face of said mold to partition a cavity formed between said cavity face of said first mold and said cavity face of said second mold into a first portion and a second portion;

a first resin-supplying unit for supplying a first molten thermoplastic resin to said first portion of the cavity;

a second resin-supplying unit for supplying a second molten thermoplastic resin to said second portion of the cavity;

a press unit, connected to said first and second molds, for moving at least one of said molds between an open position where said first and second molds are in an open state and a closed position where said molds are in a closed state and maintaining said first and second molds at a predetermined closing pressure; and

a control unit connected to said press unit, said first and second resin-supplying units, and said dam driving unit, said control unit driving said dam driving unit to cause said part of said movable dam to project into the cavity, driving said first resin-supplying unit for a first period of time to supply said first resin while said first and second molds are main-

tained in the open state by said press unit, driving said press unit to close said first and second molds at a first closing pressure and set said molds in the closed state while or after said first resin is supplied, driving said dam driving unit in a manner interlocked with closing of said first and second molds to return said movable dam into said mold, driving said second resin-supplying unit for a second period of time to inject said second resin while maintaining said first and second molds at a second closing pressure after completion of closing of said molds, and driving said press unit to open said first and second molds after a third period of time elapses from completion of injection or said second resin.

15. A mold assembly according to claim 14, wherein the open state includes a first open state wherein said molds are arranged with a cavity clearance such that a molded article between said first and second molds can be removed, and a second open state wherein the cavity clearance is smaller than that in the first open state, and said control unit drives said press unit to shift said first and second molds from the first open state to the second open state after said part of said movable dam is caused to project into the cavity, and thereafter, drives said first resin-supplying unit while maintaining said molds in the second open state.

16. A mold assembly according to any one of claims 12 to 15, further comprising a position detection unit, connected to said control unit, for detecting a position of at least one of said first and second molds.

17. A mold assembly according to any one of claims 12 to 16, wherein said control unit stops driving said first resin-supplying unit before driving of said press unit is stopped, and starts to drive said second resin-supplying unit 0 to 30 seconds after said driving of said first resin-supplying unit is stopped.

18. A mold assembly according to any one of claims 12 to 17, wherein said control unit maintains the closing pressure during closing of said first and second molds at 30 to 90 kgf/cm^2 and the closing pressure during supply of said second resin at 100 to 400 kgf/cm^2.

Fig. 1

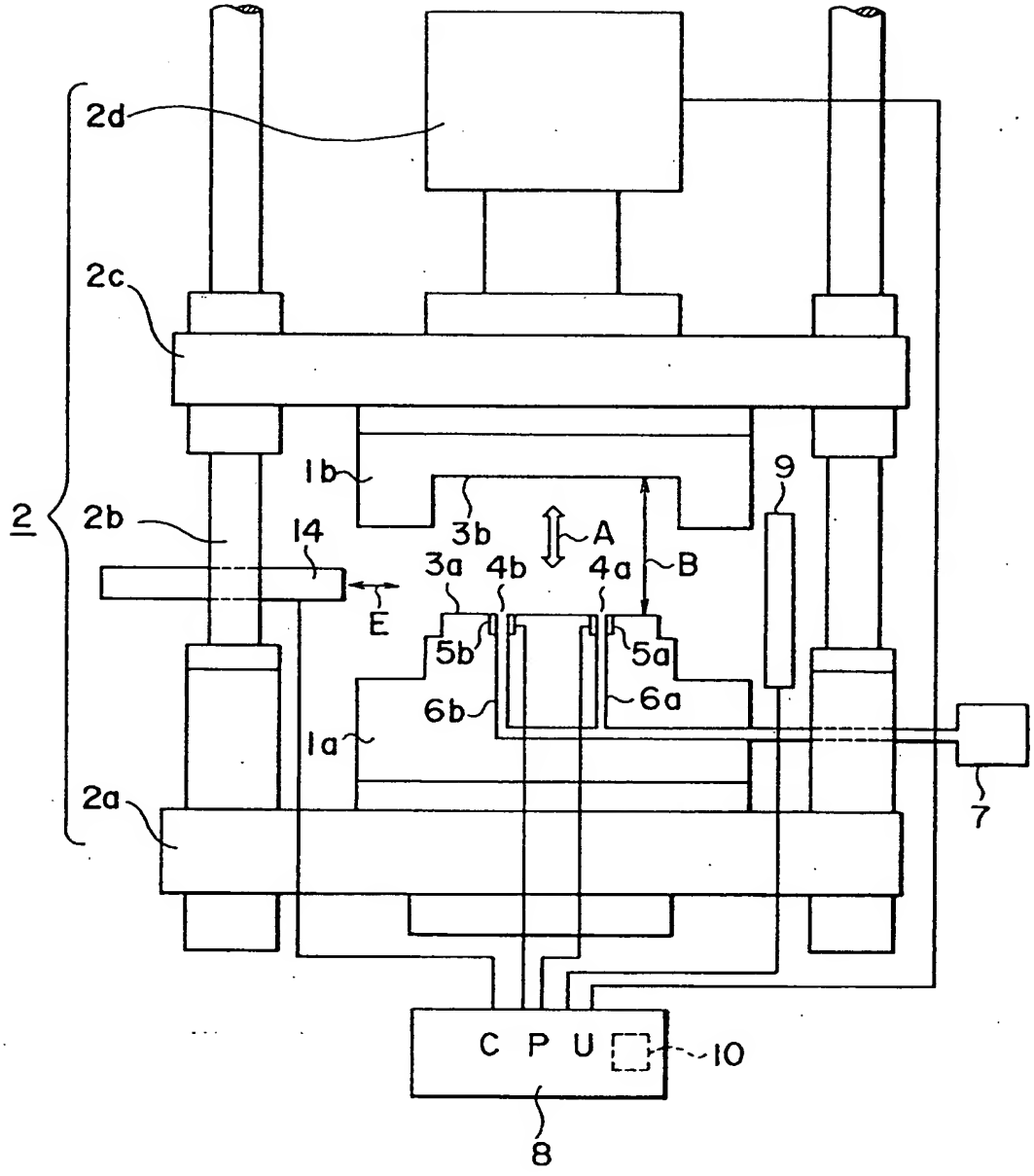


Fig. 2

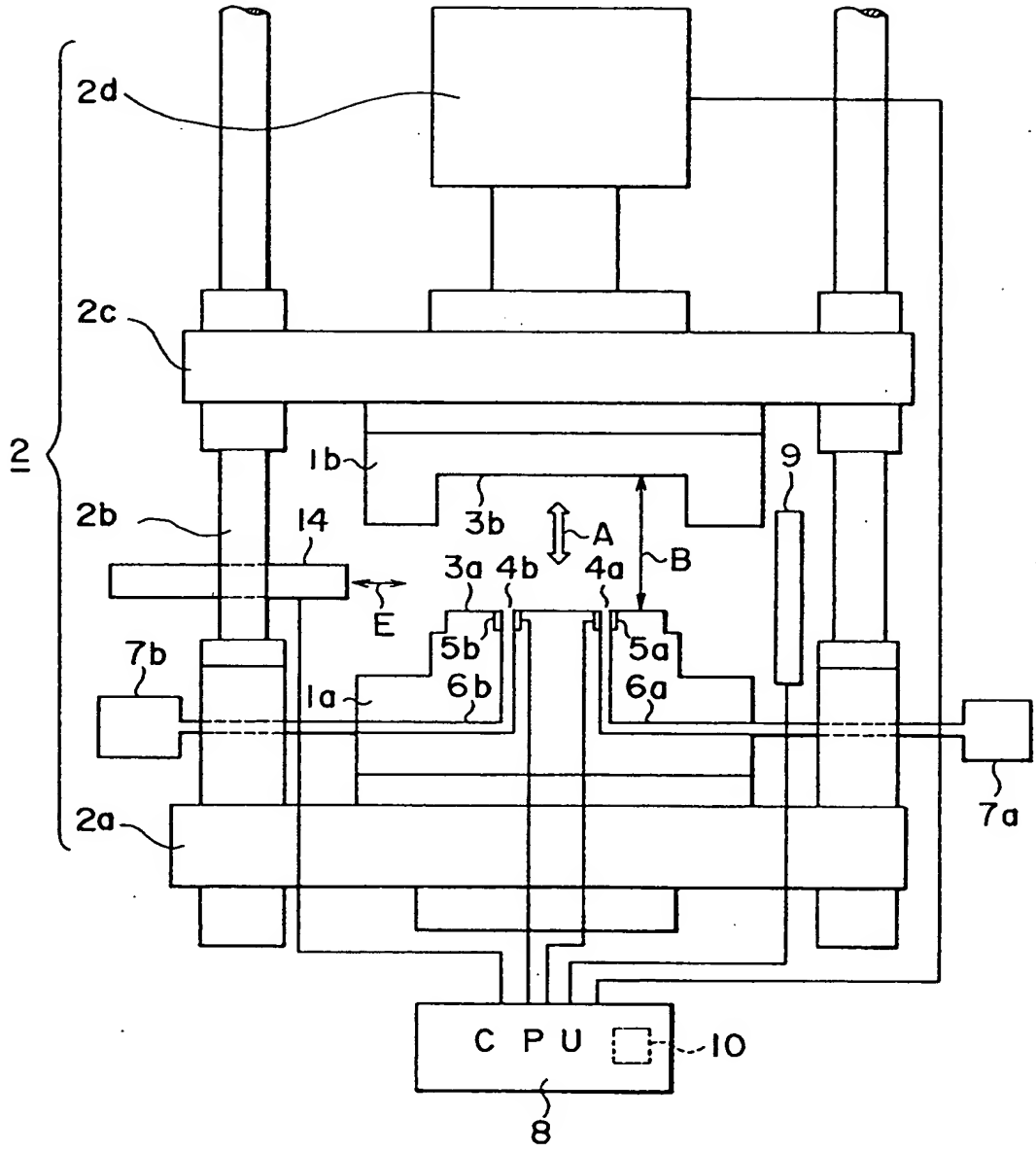
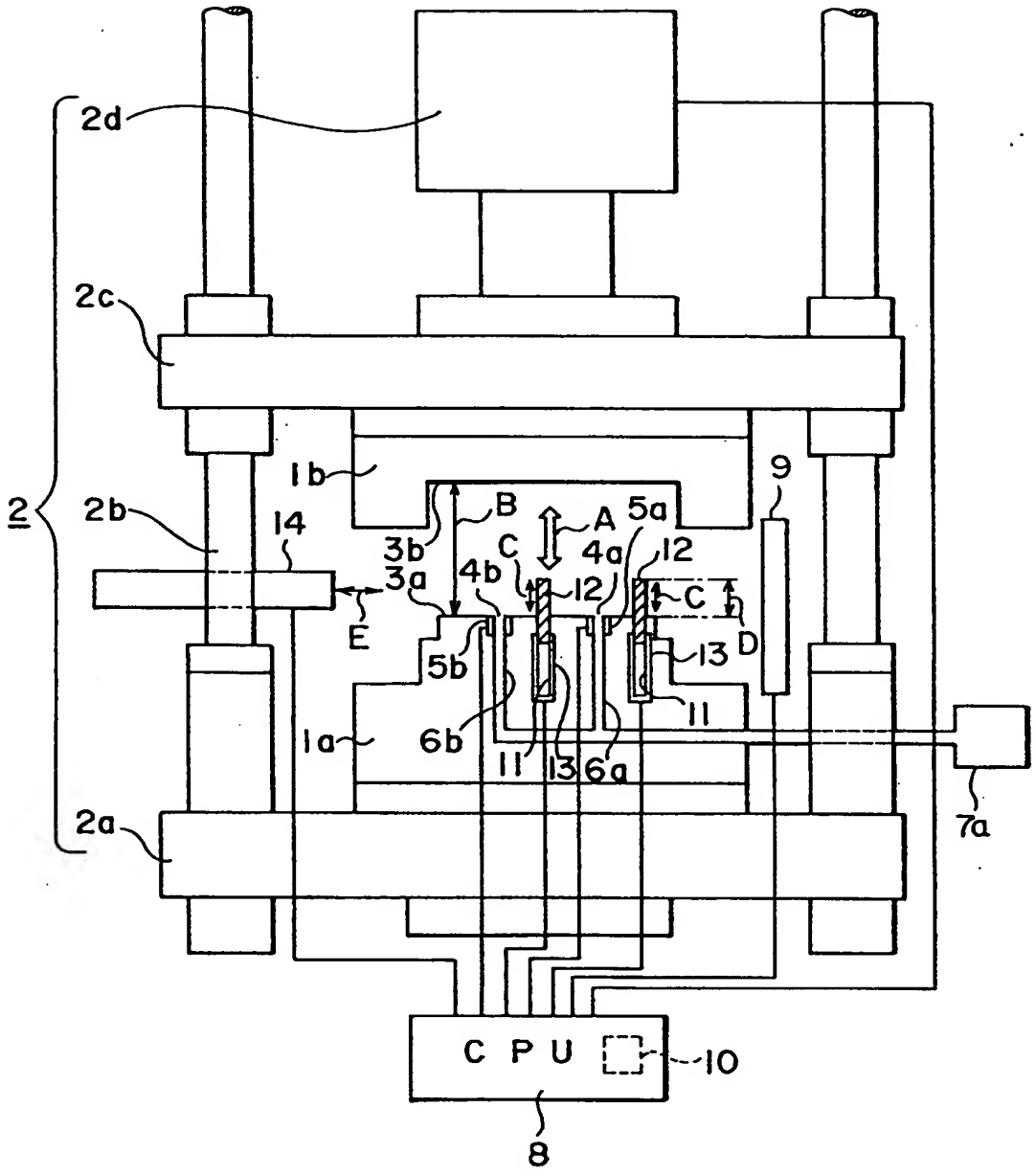


Fig. 3


2d
2c
2
2b
14
1b
3b
3a
B
A
5a
C
4a
12
4b
12
C
D
E
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11
1a
6b
11
13
6a
9
7a
2a
C P U
10
8

Fig. 4

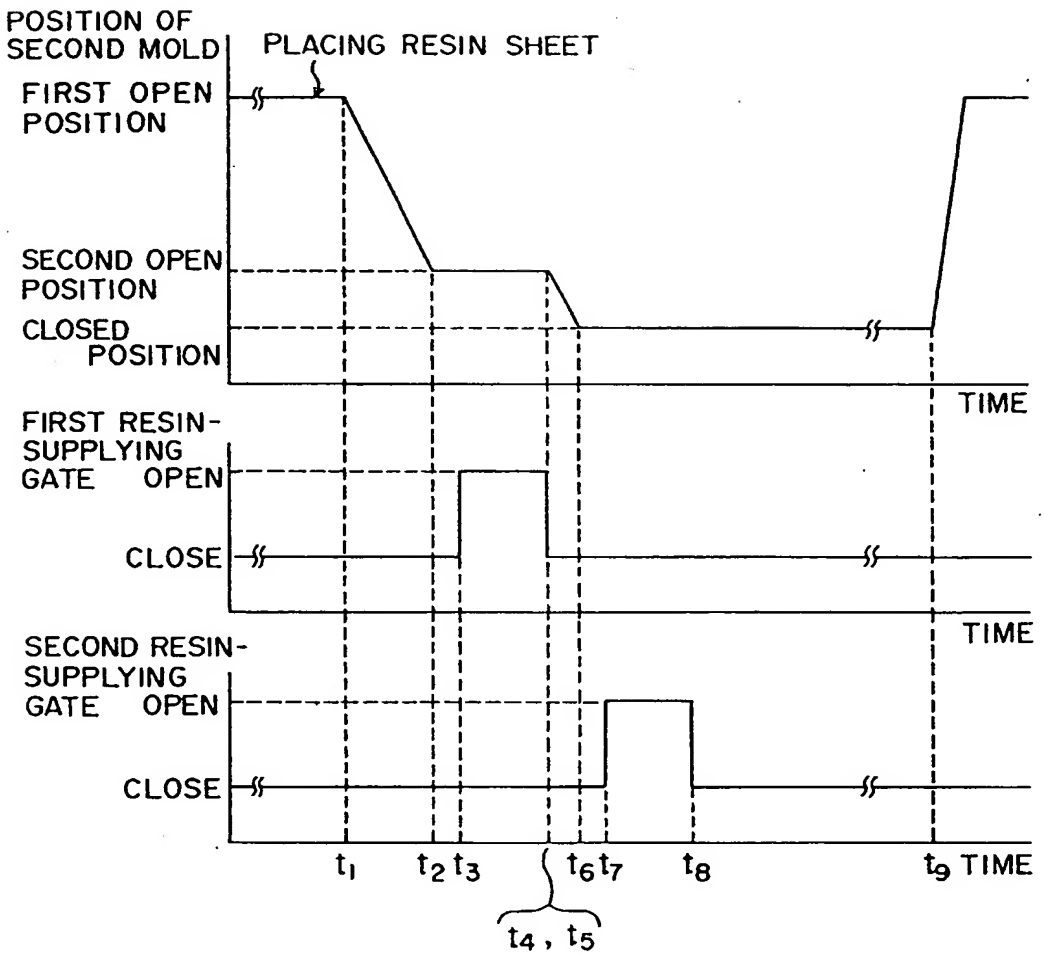

POSITION OF SECOND MOLD
PLACING RESIN SHEET
FIRST OPEN POSITION
SECOND OPEN POSITION
CLOSED POSITION
TIME
FIRST RESIN-SUPPLYING GATE OPEN
CLOSE
TIME
SECOND RESIN-SUPPLYING GATE OPEN
CLOSE
t1 t2 t3 t4, t5 t6 t7 t8 t9 TIME

Fig. 5

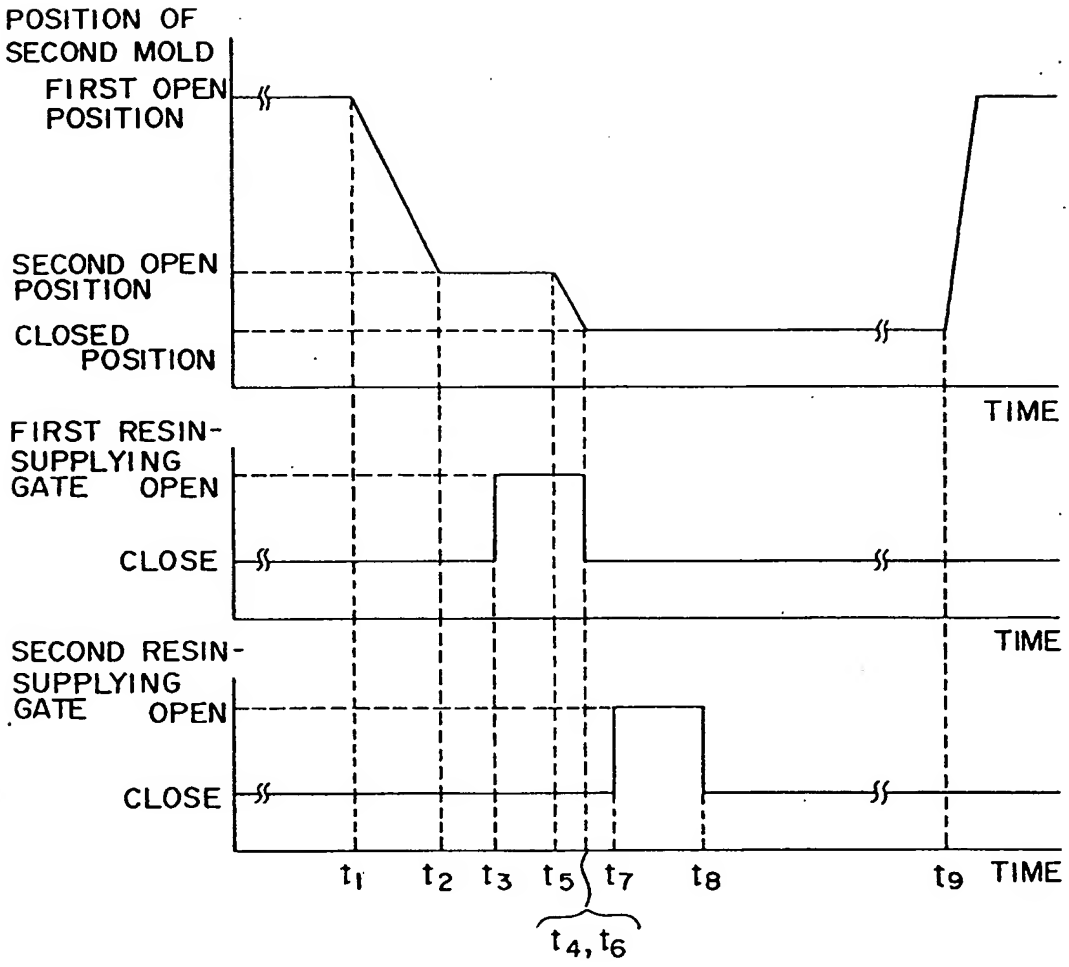

POSITION OF SECOND MOLD
FIRST OPEN POSITION
SECOND OPEN POSITION
CLOSED POSITION
TIME
FIRST RESIN-SUPPLYING GATE OPEN
CLOSE
TIME
SECOND RESIN-SUPPLYING GATE OPEN
CLOSE
t1 t2 t3 t5 t7 t8 t9 TIME
t4, t6

Fig. 6

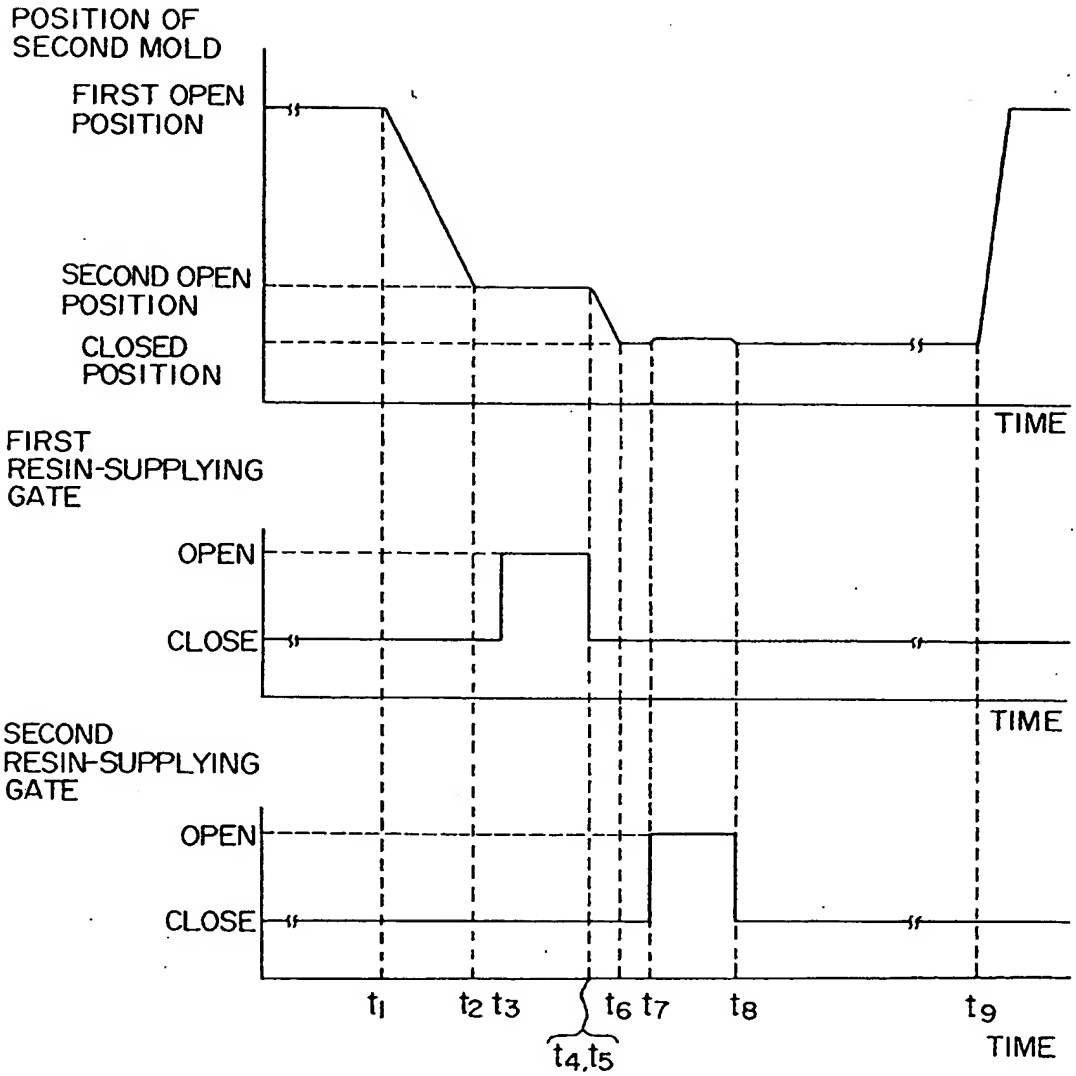

POSITION OF SECOND MOLD
FIRST OPEN POSITION
SECOND OPEN POSITION
CLOSED POSITION
TIME
FIRST RESIN-SUPPLYING GATE
OPEN
CLOSE
TIME
SECOND RESIN-SUPPLYING GATE
OPEN
CLOSE
t1
t2 t3
t4, t5
t6 t7
t8
t9
TIME

Fig. 7

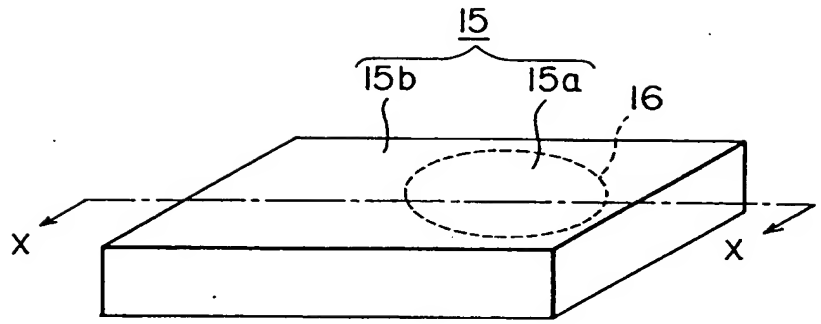


Fig. 8

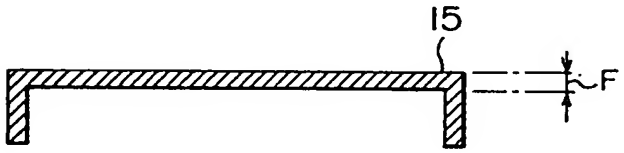


Fig. 9

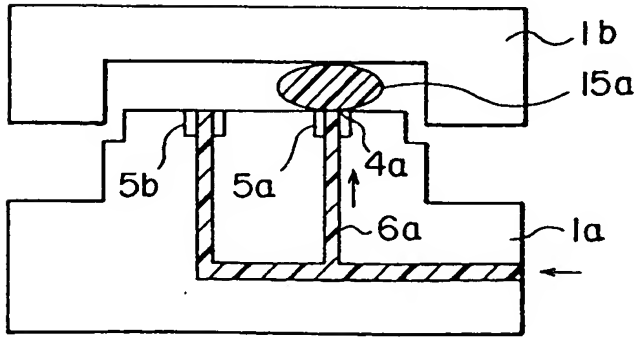


Fig. 10

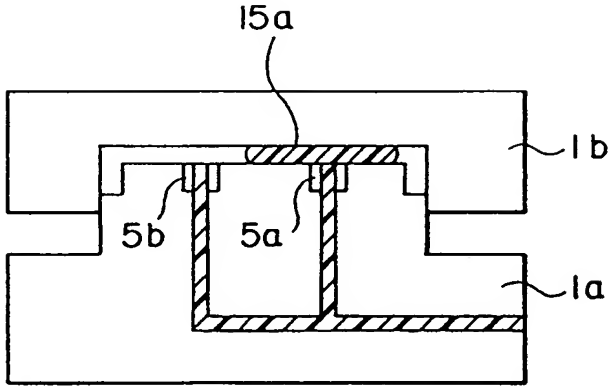


Fig. 11

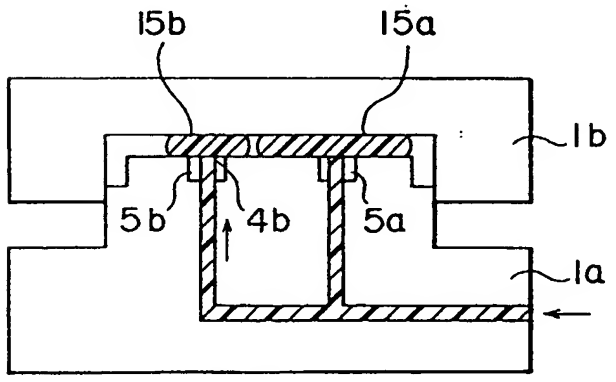


Fig. 12

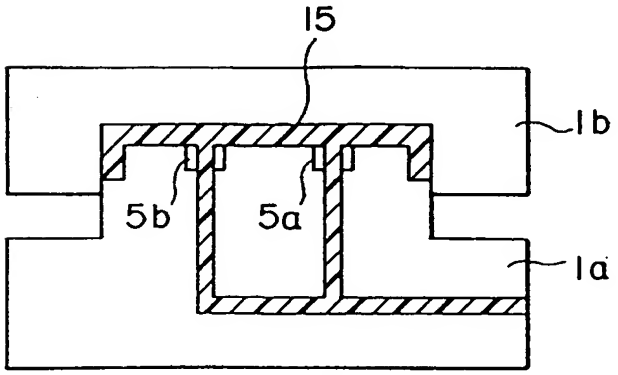


Fig.13

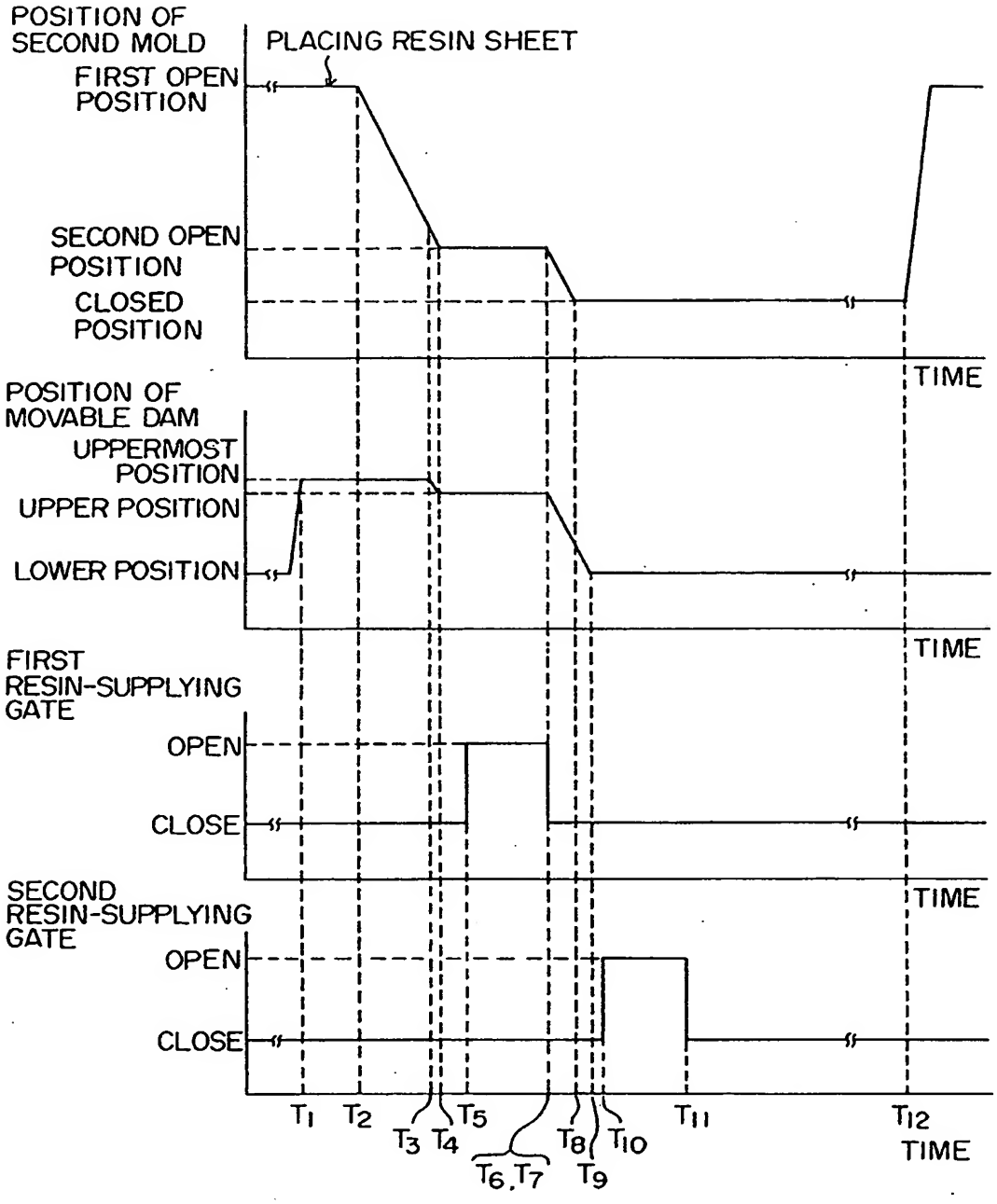

POSITION OF SECOND MOLD
PLACING RESIN SHEET
FIRST OPEN POSITION
SECOND OPEN POSITION
CLOSED POSITION
TIME
POSITION OF MOVABLE DAM
UPPERMOST POSITION
UPPER POSITION
LOWER POSITION
TIME
FIRST RESIN-SUPPLYING GATE
OPEN
CLOSE
TIME
SECOND RESIN-SUPPLYING GATE
OPEN
CLOSE
T1 T2 T3 T4 T5 T6,T7 T8 T9 T10 T11 T12
TIME

Fig.14

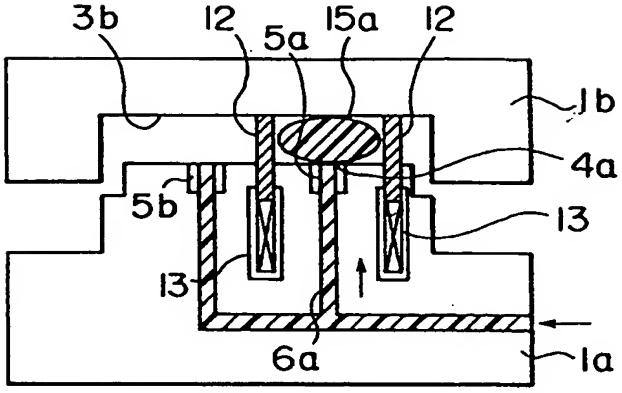


Fig. 15

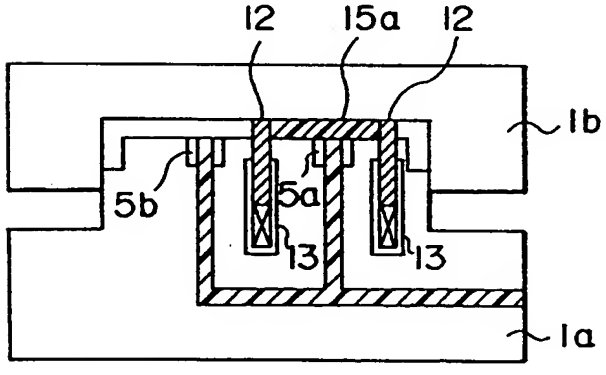


Fig. 16

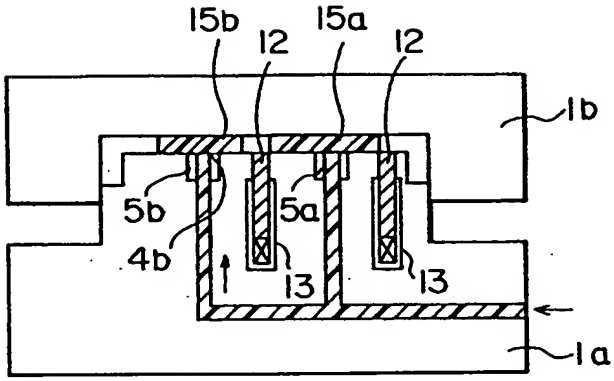


Fig. 17

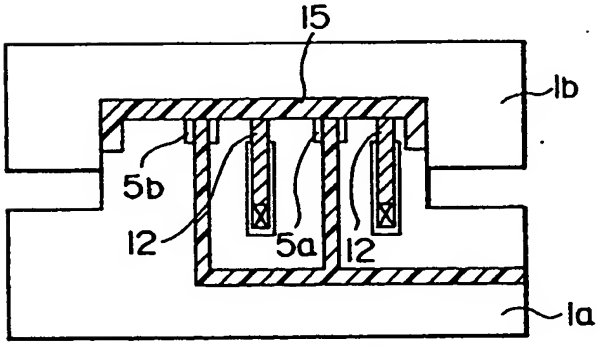


Fig. 18

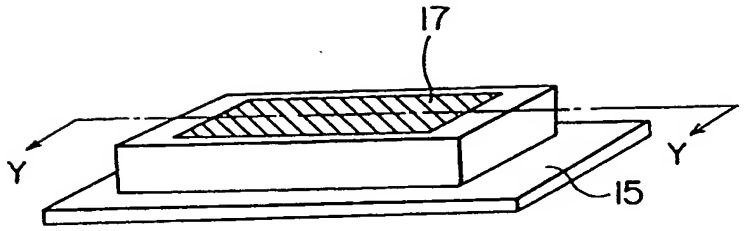


Fig. 19

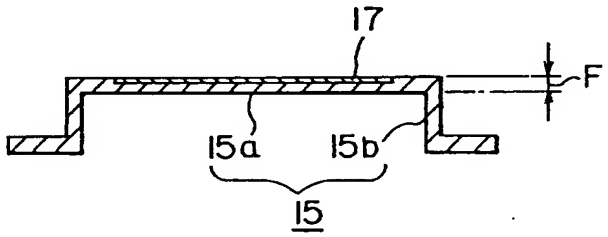


Fig. 20

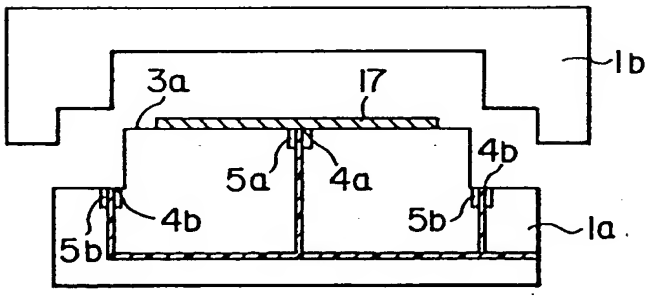


Fig. 21

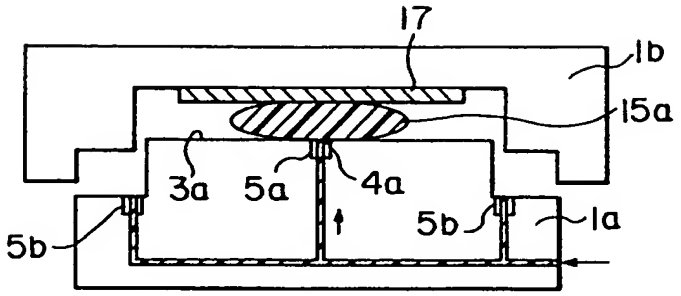


Fig. 22

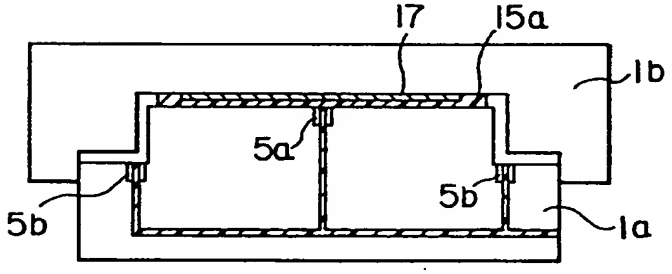


Fig. 23

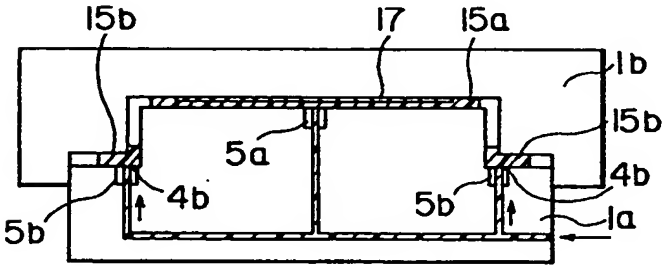


Fig. 24

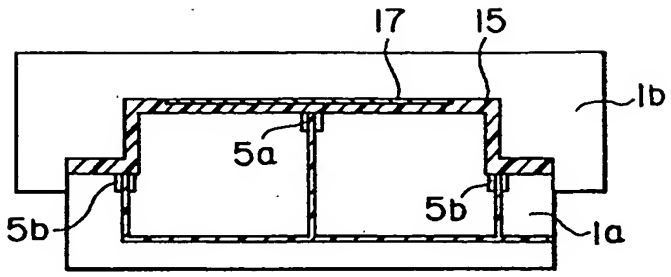


Fig. 25

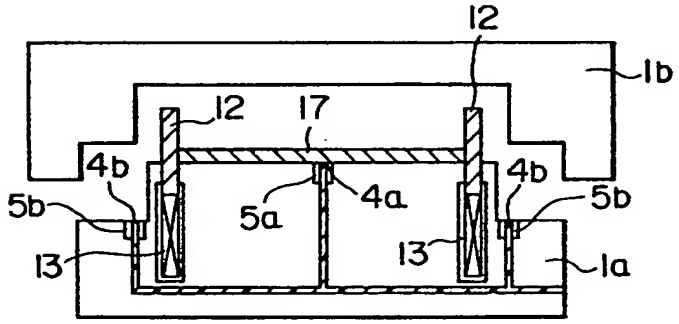


Fig. 26

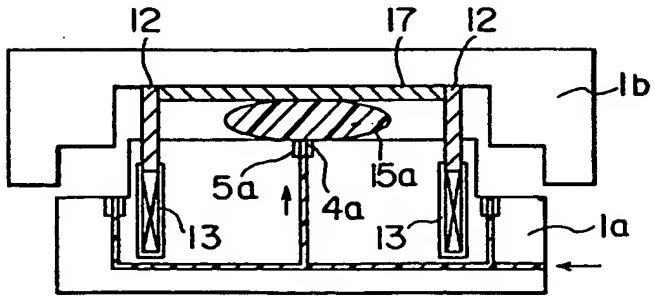


Fig. 27

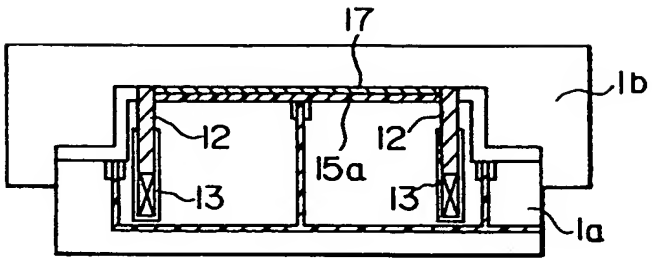


Fig. 28

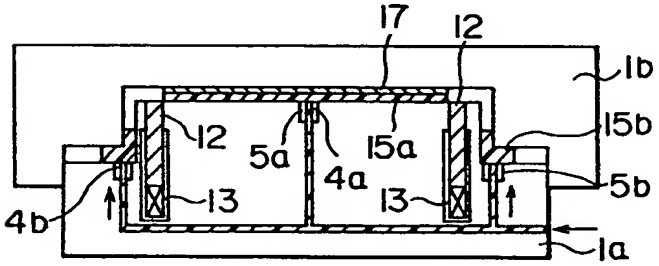
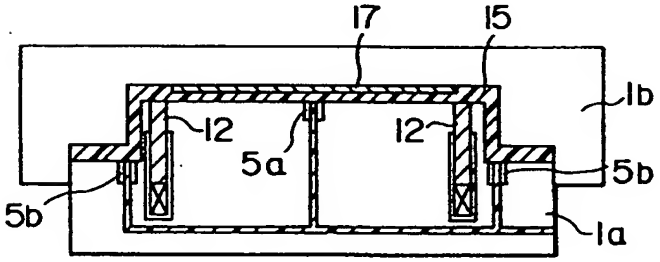


Fig. 29



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 11 0729

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	GB-A-2 271 956 (TOYODA GOSEI CO LTD) 4 May 1994 * the whole document *	1-9, 11-15,17	B29C45/56 B29C45/16
X	FR-A-2 616 374 (NIPPON SHEET GLASS CO LTD) 16 December 1988 * page 7, line 1 - line 16; claims 1-3; figures *	1,2,8,9, 12	
P,A	PATENT ABSTRACTS OF JAPAN vol. 940 no. 011 & JP-A-06 328579 (SHOWA DENKO KK) 29 November 1994, * abstract *	1,2,8,12	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B29C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 October 1995	Bollen, J

CATEGORY OF CITED DOCUMENTS

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